

# **An EOF Iteration Approach for Obtaining Homogeneous Radiative Fluxes from Satellites Observations**

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## ***Abstract***

Conventional observations of climate parameters are incomplete in space and/or in time and the representativeness of such information needs to be optimized. Observations from satellites provide improved spatial coverage than point observations however they pose new challenges for obtaining homogeneous coverage. Surface radiative fluxes, the forcing functions of the hydrologic cycle and biogeophysical processes, are now becoming available from global scale satellite observations. They are derived from independent satellite platforms and sensors that differ in temporal and spatial resolution, and in the size of the footprint from which information is derived. Data gaps, degraded spatial resolution near boundaries of geostationary satellites, and different viewing geometries in areas of satellite overlap, could result in biased estimates of radiative fluxes. In this study, discussed will be issues related to the sources of inhomogeneity in surface radiative fluxes as derived from satellites; development of a methodology to obtain homogeneous data sets; and application of the methodology to the widely used International Satellite Cloud Climatology Project (ISCCP) data that currently serve as a source of information for deriving estimates of surface and top of the atmosphere radiative fluxes. Introduced is an Empirical Orthogonal Function (EOF) iteration scheme for homogenizing the fluxes. The scheme is evaluated in several ways including comparison of the inferred radiative fluxes against ground observations, both before and after the EOF approach is applied. On the average, the latter reduces the rms error by about 2-3 W/m<sup>2</sup>.

## ***Popular Summary***

To advance the understanding of the water cycle and land-atmosphere interactions on global scale, information on radiative fluxes is needed at similar scales, and can be obtained from satellite observations. Only recently global scale satellite observations at climatic time scales have become available. While issues related to paucity of data have been addressed in the past, each climatic parameter poses a unique challenge for obtaining homogeneous time series representative of large spatial scales. The most widely used parameter to study climate variability is surface temperature, either at shelter level over land stations, or sea surface temperature (SST), as derived both from satellites and in-situ observations. Reynolds and Smith (1995) developed an optimal interpolation (OI) technique implemented weekly at 1° resolution using ship and buoy data of SST and satellite data. In their approach attention is given to the removal of large-scale biases of satellite data, as compared to in situ data. Smith et al. (1996) expanded this approach by using the best estimates of the full covariance structure of the mean SST fields to fit the in situ data and fill data gaps. They used spatial functions defined by empirical orthogonal functions (EOF), computed from a principal component analysis (PCA). It is claimed that this approach is an improvement over the OI method, which utilized local

interpolation with modeled covariance functions, while in the newer scheme basin wide covariance structures are used. Other studies dealt with various aspects of interpolation needs of climatic parameters, emphasizing different aspects of the problem. For example, Rayner et al. (1995) attempt to improve global long term sea ice and SST analysis while Shriver and O'Brien (1995) address the wind stress issue.

The radiative fluxes at the boundaries of the atmosphere are computed by determining atmospheric transmission and reflection (optical functions) and the surface albedo, pertaining to a particular satellite observation.. To obtain homogeneous and coherent radiative fluxes from the satellite observations requires addressing issues related to uneven sampling, data gaps, degraded spatial resolution as one moves away from the nadir, and different viewing geometries in areas of overlap. The Empirical Orthogonal Function (EOF) iteration scheme is well suited for getting integrated, smoothed, high-resolution surface radiative fluxes, because in this approach, spatial modes are derived statistically from available observations and then used to reconstruct the information in areas of degraded data quality.